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UNITED STATES ARMY FORCES, PACIFIC

OFFICE OF THE CHIEF SURGEON

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CIRCULAR LETTER NO. 36

ANAEROBIC INFECTION OF WOUNDS

1. GENERAL.

a. The purpose of this communication is to acquaint medical officers with the more recent developments in the classification, prevention, diagnosis, treatment, and prognosis of anaerobic infection of war wounds.

b. Anaerobic infection of wounds is caused by a variety of bacteria possessing varying degrees of pathogenicity. The clinical course of such an infection is dependent upon the pathogenicity of the organism and the character of the wound in which it is growing. Anaerobic bacteria are so widely distributed in nature - in soil and sand, in dust of all kinds and in the alimentary tracts of animals that their presence in war wounds is expected. The same pathogenic bacteria may result in widely different effects depending on whether conditions in the wound are favorable to growth; thus *C. perfringens* (welchii) may equally well be found in a healthy wound and in a man dying from gas gangrene. For these reasons the criteria for the classification of anaerobic infection of wounds are based primarily on clinical findings, and secondarily on the presence of pathogenic bacteria.

c. Simple Contaminations - The chief source of infection is from the clothing worn by the soldier which even under conditions found in the desert is highly contaminated with anaerobic bacteria. Anaerobic bacteria, including the pathogenic varieties, can be found in most war wounds. These may not produce clinical symptoms and unless there is gross infection from pyogenic cocci the anaerobes disappear rapidly from the wound. There may be no invasion although they may proliferate in the necrotic tissue in the wound. However, it is from such simple contaminations that the more serious forms of anaerobic infection arise.

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2. CLASSIFICATION.

a. Anaerobic infections fall into three (3) types: anaerobic cellulitis, clostridial myositis, and streptococcal myositis.

(1) Anaerobic Cellulitis.

(a) This is the most common type of anaerobic infection producing clinical signs and symptoms and may be caused by a variety of bacteria. In the past it frequently has been erroneously diagnosed and treated as "gas gangrene". It differs from clostridial myositis in that, while the anaerobes produce gas, they do not produce a myotoxin and, lacking the power to invade living muscle, they spread more slowly and produce mild toxic effects.

(b) The bacteria in anaerobic cellulitis are limited to the depth and crevices of the wound and tissue spaces leading therefrom - living muscle is not invaded although bacteria may be found in muscle already killed by trauma or vascular damage. The anaerobes continue to multiply and spread in the cellular connective tissue producing gas which opens up the connective tissue spaces and thus aids the spread of the infection. These bacteria may not be strictly pathogenic nor belong to the toxigenic clostridia, but none the less they produce a very definite clinical syndrome. Such infections vary from a "gas abscess" to the extensive involvement of a limb.

(c) The diagnosis of anaerobic cellulitis is based on the clinical findings. It is characterized by a gradual onset, little or no toxemia, abundant gas formation and only a slight elevation of temperature or pulse. This clinical picture may be modified by the presence of such bacteria as hemolytic streptococci in which case the toxic symptoms may be more marked, the temperature and pulse more elevated, and the wound more painful.

(2) Clostridial Myositis.

(a) This is the second most common type of anaerobic infection of wounds. Infection is not limited to the necrotic debris in the tissue spaces of the wound but adjacent tissues become involved with appalling rapidity. The causative bacteria are one or more of the following spore bearing anaerobic bacilli listed in the order of frequency in which they have been isolated from wounds: a. Cl. Perfringens (welchii) b. Cl. oedematiens, c. Cl. septicum, d. Cl. histolyticum e. Cl. bifermentans, and f. Cl. fallax.

(b) Clostridial Myositis is an acute, rapidly spreading infection, always with a sudden onset. The incubation period usually is short although rarely it may develop several weeks after injury. Pain is a very common symptom, sudden in the onset and increasing in severity. When due to Cl. oedematiens it is often described as a sense of weight. Edema may be severe and swelling is progressive. Toxemia is profound and progressive and frequently associated with abnormal psychic reactions. Hyperpyrexia is usually present but the temperature may not be very high. The pulse rate ordinarily is increased, frequently out of proportion to temperature, and the volume deteriorates as the disease advances. This description applies to any of the pathogenic clostridia although the symptoms may vary according to the virulence and strain. Hyperpyrexia and hemolytic anemia are more common in Cl. perfringens (welchii) than in the other types and gas is profuse. Cl. oedematiens is characterized by less gas and more marked edema. Examination of the wound early may reveal remarkably little other than edema and tenderness. Gas at this stage may not be obvious and is frequently absent. Repeated examination at hourly intervals may reveal a different picture. The sense of smell is unreliable as a diagnostic sign. Discoloration of the skin in the early stages is frequently absent.

(3) Streptococcal Myositis.

This is the third and least common of the anaerobic infections in war wounds. The symptoms are similar to clostridial myositis but are less acute. It spreads more slowly and the onset is more likely to be insidious. Nevertheless, as the disease progresses the signs and symptoms, including pain and toxemia, may become severe. The presence of gas may be masked by severe edema which is characteristic of this type of infection. Rapidly spreading cutaneous erythema is usually present. The clinical picture may vary according to the secondary infecting organism. Anaerobic streptococci seldom are found alone but usually are associated with Strep. pyogenes or Staph. pyogenes.

3. DIAGNOSIS.

a. The diagnosis of Anaerobic Wound Infection must:

(1) Primarily be based on the clinical symptoms and the appearances of the wound rather than on the bacteriological findings in order that proper treatment may be instituted early.

(2) Secondly be based on the bacteriology in order that we may make the diagnosis more accurate and provide data on which to base more effective treatment. The presence of anaerobic bacteria in the absence of appropriate symptoms and signs indicates contamination rather than wound infection.

b. Anaerobic Wound Infection is frequently caused by a mixture of bacteria hence the symptoms and signs in the following table may overlap:

- - - - -DIFFERENTIAL DIAGNOSIS- - - - -

	Anaerobic Cellulitis	Clostridial Myositis (Gas gangrene)	Streptococcus Myositis
Incubation	Almost always over 3 days	Usually under 3 days	3 - 4 days
Onset	Gradual	Acute	Subacute or insidious
Toxemia	Nil or slight	Very severe	Severity delayed
Pain	Absent	Severe	Variable - may be severe
Swelling	Nil or slight	Marked	Marked
Skin	Little change	Tense - often white	Tense - often coppery
Exudate	Slight	Variable - may be profuse.	Profuse: Seropurulent
Gas	Abundant	Early slight - increases rapidly	Very slight
Muscle	No change	Marked change	At first little but edema
Smell	Foul	Variable - may be slight	Very slight

CAUTION: Crepitus and gas in the wound or gas in the X-ray may be caused by the explosive trauma of a missile, anaerobic cellulitis, non-pathogenic bacteria, or true gas gangrene.

(1) Avoid diagnosing clostridial myositis because of the local appearance of the wound unless a systemic reaction. (Toxemia, temp, pulse), is present.

(2) Clostridial Myositis requires early diagnosis and treatment. If the diagnosis is uncertain repeated hourly examination of the patient is indicated. Do not evacuate patient if diagnosis is suspected unless compelled by the tactical situation.

(3) Pain is an early and frequent symptom of clostridial myositis. Do not neglect to examine the wound if pain is disproportionate.

(4) Gas in early clostridial myositis may be minimal or its presence may be obscured by edema. This is especially true if infection is due to *Cl. oedematiens* which is most frequently overlooked.

(5) The odor of gas gangrene may not be present. It is an unreliable sign on which to base a diagnosis.

(6) The color of the skin is not diagnostic but varies with the hemolyzing properties of the organism and the presence of streptococci.

(7) In clostridial myositis at operation the bacteria may be demonstrated in living muscle by a gram smear. Non-pathogenic clostridia, however, may be found in dead muscle.

4. PREVENTION OF ANAEROBIC INFECTION.

a. The methods of preventing all types of anaerobic wound infections are based on the same fundamental principles. Hence, anaerobic cellulitis, clostridial myositis and streptococcal myositis will be discussed together.

b. Surgery is still the only effective method of preventing anaerobic wound infection. Chemotherapeutic agents are valuable adjuncts but they do not lessen the need for meticulous surgical technique.

c. The factors necessary for anaerobic wound infection are:

(1) The presence of specific pathogenic bacteria.

(2) Anaerobic conditions in the wound favorable to their growth such as:

- (a) Dead tissue (especially muscle).
- (b) Foreign bodies (especially clothing)
- (c) Poor blood supply.

d. Factors which determine whether anaerobic wound infection develops:

(1) Phagocytosis is the first line of defense if the blood supply to the part is intact and the phagocytes can reach the bacteria. Dead tissue (especially muscle), foreign bodies (especially clothing), damage to blood supply, constricting bandages, and low blood pressure (shock) prevent phagocytosis.

(2) The number of bacteria as determined by:

- (a) The degree of contamination.
- (b) The time lag before operation.

e. Surgical Prevention by Debridement should,

- (1) Remove bacteria (excise tissue) (flushing).
- (2) Remove dead tissue (muscle) (blood clot).
- (3) Remove foreign bodies (clothing) (dirt)
- (4) Prevent introduction of bacteria (sterile technique).

f. Maintain adequate blood supply by:

- (1) Transfusion of whole blood.
- (2) Incise fascia to provide free drainage.
- (3) Avoid packing to control hemorrhage (careful hemostasis).
- (4) Avoid primary suture.
- (5) Avoid constricting bandage or tourniquet. Be sure plaster cast is cut.

g. Prophylactic Chemotherapy and Antitoxin.

(1) Penicillin, sulfonamides or antitoxin in order to accomplish their purpose must:

(a) Affect the specific bacteria causing the infection.

(b) Must be given in adequate dosage.

(c) Must reach the bacteria via the blood stream or directly.

(2) Prophylactic chemotherapy has so far been disappointing.

(a) None of these agents affect all bacteria. Usually a number of different bacteria are present. Less than 1/3 of the cases are caused by *Cl. perfringens (welchii)* alone.

(b) The dosage is frequently inadequate.

(3) None of these agents can provide prophylaxis by themselves without adequate surgery. In order for the agent to reach the bacteria, the blood supply must be intact and dead tissue removed.

(4) There is no evidence that antitoxin is effective in preventing clostridial myositis and its use is not recommended for this purpose.

(5) There is some evidence that penicillin may be effective in combination with meticulous surgery and its use is recommended in full therapeutic dosage when anaerobic wound infection is suspected.

h. Facts about Clostridial Myositis which may help in prevention by more meticulous surgery:

(1) Mortality 4 times greater if operation delayed over 40 hours.

(2) Postmortem examination frequently reveals foreign bodies (especially clothing).

(3) Seventy-five (75) percent of infection occurs in the lower limb. Half of these are below the knee.

(4) The higher the location of the wound the higher the mortality.

(5) Two-thirds of infections occur in compound fractures.

(6) One-third of infections occur in major vascular injury.

(7) Give triage priority for wounds suspected of clostridial myositis.

5. TREATMENT.

a. General.

(1) The treatment of all anaerobic wound infection is based on the same fundamental principles. However, the urgency of treatment and indications for being conservative or radical depend on the diagnostic classification of (1) anaerobic cellulitis, (2) clostridial myositis, (3) streptococcal myositis.

(2) The present high mortality of anaerobic wound infections, and especially clostridial myositis, indicates the need for prompt treatment, continued observation and painstaking attention to detail. Patients who have or are suspected of having anaerobic wound infections should not be evacuated until the infection is under control and therapy discontinued. Because of the high incidence of infection following major vascular lesions, it is advisable not to evacuate these cases until adequate collateral circulation has been established.

b. Anaerobic Cellulitis (Low Mortality) (Gradual Onset).

(1) Surgery.

(a) Debridement primary or secondary is indicated.

(b) Remove dead tissue and foreign bodies.

(c) Relieve tension by incising fascia.

(d) Provide drainage.

(e) Amputation is seldom necessary but may be indicated if there is severe damage to blood supply with secondary infection.

(2) Penicillin intramuscularly or intravenously should be given in full therapeutic dose.

(3) Gas gangrene antitoxin does not appear to be required on the basis of clinical experience.

(4) Transfusions of whole blood are indicated if RBC is below four million.

(5) Anaerobic cellulitis may progress to clostridial myositis if not adequately treated.

(6) Death is usually due to complications such as (thrombophlebitis-pulmonary embolism).

c. Clostridial Myositis (Mortality 50%)
(Treatment urgent).

(1) Surgery immediate and radical. Majority of deaths occur within 24 hours. Chemotherapy, antitoxin, and transfusion may be given simultaneously.

(a) Radical excision of dead and infected tissue is necessary and may involve whole muscle groups.

(b) Amputation through normal muscle is usually indicated if the blood supply is impaired, structural damage severe or if clostridial myositis is diffuse.

(2) Penicillin intramuscularly or by drip method. Dose 100,000 units immediately with 300,000 units in first 24 hours. Penicillin alone is not curative.

(3) Antitoxin alone is not curative but of value if specific for clostridia involved. Recommended intravenous dose: three (3) ampules every hour for six hours or longer if needed.

(4) Transfusions of whole blood to raise Hb to normal (this is essential), and repeat at frequent intervals as needed.

d. Streptococcal Myositis (Mortality 26%)
(Onset insidious).

(1) Surgery - Release tension by incising fascia. Remove dead tissue, foreign bodies and provide drainage.

(2) Gram stained smear of muscle may be needed for diagnosis. This is important since more conservative surgery is indicated than for clostridial myositis.

(3) Penicillin is theoretically more effective than sulfonamides since staphylococci are frequently present. Both may be used.

(4) Transfusion of whole blood is needed to raise Hb to normal.

7. STUDY AND REPORTING OF ANAEROBIC WOUND INFECTION.

A uniform method of reporting cases of anaerobic wound infection is necessary in order that adequate data may be obtained regarding this problem. Technical Memorandum No. 27, dated 23 December 1944, paragraph 2, relative to the reporting of gas gangrene treated with penicillin is hereby rescinded. Each case of anaerobic wound infection, when completed, will be reported on the form shown in inclosure (1). This report will be forwarded through Medical Channels to the Chief Surgeon, General Headquarters, AFPAC. Cultures of aerobic and anaerobic organisms and viable muscle should be sent for further study to the Commanding Officer, 19th General Medical Laboratory, APO 565, Unit #2.

Paul Robinson
Col. M.C.

for and in the absence of
GUY B. DEWIT,
Brigadier General, U. S. Army,
Chief Surgeon

1 Incl.

Report of Anaerobic Wound Infections.

DISTRIBUTION: B(D)

INCLOSURE I

REPORT OF ANAEROBIC WOUND INFECTIONS

1. This report will be completed on each case of anaerobic wound infection and upon disposition of the case it will be forwarded through medical channels to the Chief Surgeon, General Headquarters, AFPAC, APO 500. (Attach extra record if desired).

2. Name of Hospital: APO:

3. Name of Patient: Serial No:

4. History, to include:

a. Cause of Wound (rifle bullet, shell fragment, etc.):

b. Where and how wound occurred:

c. Date and hour of wound:

d. Was blood supply impaired? Name major vessels involved:

e. Date and hour anaerobic infection diagnosed (clinical):

5. Examination - Describe signs and symptoms, temperature, pulse, pain, location of wound and whether associated with compound fracture.

6. Classification: (Check one)

a. Anaerobic Cellulitis (), b. Cl. Myositis ();

c. Streptococcal Myositis ().

7. Laboratory Data.

a. Bacteriology:

(1) Smear - Morphologic types recognized.

(2) Cultural data (include media employed).

(a) Aerobic.

(b) Anaerobic.

b. Blood

RBC

HB

8. Treatment.

a. Date and hour first treatment for anaerobic infection (Brief Description):

b. Operations for anaerobic infection. Date and hour (Brief Description).

c. Give date, hour, dosage and duration, and state which were used and which not used:

(1) Penicillin.

(2) Antitoxin (Specify manufacturer, item no. and nomenclature).

(3) Sulfonamides.

(4) Whole blood.

9. Complications.

10. Opinion as to factors causing infections, such as:

a. Foreign bodies (clothing, dirt, fragments).

b. Major blood supply impaired.

c. Diminished blood supply due to:

(1) Constricting bandage - cast.

(2) Fascia not incised.

d. Dead muscle present.

11. Opinions as to results of therapy: (Include cause of death).

12. Disposition:

Duty,

Trfd.

Died

Signature: _____ Rank _____ Org _____